PUPILS' OUTLINES FOR HOME STUDY

IN CONNECTION WITH SCHOOL WORK

PHYSIOLOGY

By D. E. AXELSTROM

Price, Fifteen Cents

JENNINGS PUBLISHING COMPANY
P. O. Box 17, Brooklyn, N. Y.

PHYSIOLOGY

Anatomy—treats of the location and structure of the organic bodies.
Physiology—treats of the appearances and uses of the living organs.
Hygiene—treats of the preservation of health.

HUMAN BODY

It is made up of cells.

I. **Definitions.**

Cell—a small portion of protoplasm, a substance like the white of an egg. A very small spherical body, the NUCLEUS, floats in it. Cells take food, grow, and multiply by the division of the cell.

Tissue is a group of similar cells all of which do the same kind of work.

Organ is tissue or a group of tissue fitted for some special work.

II. **Composition of body.**

A. Water.
B. Solid matter (about $\frac{1}{3}$).
   1. Minerals (salt, soda, lime, iron).
   2. Proteids (substance like the white of an egg).
   3. Fat.
   4. Carbohydrates (sugar, starch).

III. **Plan of Body.**

A. Head—trunk—limbs.
B. Dorsal cavity, containing the brain and spinal cord.
C. Ventral cavity, containing
   1. Thoracic cavity, which contains heart, lungs, and important blood-vessels, and is separated by the diaphragm from the
   2. Abdominal cavity, which contains stomach, intestines, liver, pancreas, kidneys, spleen.

SKELETON—OSSEOUS SYSTEM

I. **Skeleton** is the union of the 206 bones forming the framework of the body.

II. **Purpose.**

A. To support the body.
B. To protect vital organs, as the brain, spinal cord, etc.
C. To afford levers on which attached muscles may move.

III. **Parts.**

A. *Head*—twenty-eight bones.
B. *Trunk*—fifty-eight bones.
C. *Extremities*--one hundred twenty bones.

IV. **Head**—twenty-eight bones forming the SKULL. Eight bones united form the CRANIUM, protecting the brain. Six small bones form the EARS, fourteen bones (six in pairs, one for the jawbone and one between the nostrils) form the FACE.

V. **Trunk**—fifty-eight bones.

A. **Spinal Column**—about twenty-eight inches long in the average adult and curved to prevent sudden jar at the base of the brain.

1. **Vertebrae**—twenty-four small circular bones fitted one on top of the other with pads of cartilage between, giving spring to the back.

2. **Sacrum**—a large bone between the vertebrae really made up of five vertebrae mingled into one.

3. **Coccyx**—curved end of the sacrum, really four vertebrae mingled into one.

4. **Use** of **Spinal Column.**

a. Protects spinal cord found in the opening through the center of the vertebrae.

b. Protects nerve roots coming from the cord through the openings between the vertebrae.

c. Supports the head, trunk, and arms.

B. **Sternum** or **breast-bone**—irregular bone with a flat double curve, found in the front of the chest.

C. **Ribs**—twenty-four, twelve pairs joined to vertebrae at the back.

1. **True Ribs**—first seven pairs are fastened to the sternum in front and to the vertebrae in back.

2. **False Ribs**—next three pairs are attached in front to the lowest true rib and in back to the vertebrae.

3. **Floating Ribs**—the two lowest pairs not attached at the front, but attached to the vertebrae in back.

4. **Use.**

a. Protects the organs in the ventral cavity.

b. Forms a framework to which the muscles are attached.

VI. **Extremities**—one hundred twenty bones.

A. **Upper.**

1. **Shoulder Bones.**

a. **Clavicle** or **collar-bone** (six bones) one end joined to the sternum, the other rests against the shoulder.

b. **Scapula** or **shoulder-blade,** two flat bones at the back of the shoulder and has a socket into which the end of the arm-bone fits. It is fastened by ligaments to the ribs and vertebrae.

2. **Arm.**

a. **Humerus** (two large bones) one in each upper part of the arm joined to the clavicle and scapula at the shoulder.

b. **Radius** } one of each in each lower part of the arm and joined to
c. **Ulna** } the upper arm forming the *elbow.*

3. **Wrist - Carpals** - sixteen, eight in each arm.

4. **Hand - Metacarpals**—ten bones, each bearing a finger.

5. **Finger - Phalanges**—twenty-eight, thumb has two, all the other fingers have three each.

B. **Lower.**

1. **Pelvis** or **hip-bones** two wide-spreading bones joined to the sacrum in back and to each other in front and with the coccyx make the pelvis. Use—to support the lower abdominal organs.

2. **Leg.**

a. **Femur**—two large bones, one in each upper part and joined to the pelvis giving the hip-joint.

b. **Tibia** - two }
c. **Fibula**—two } one in each leg below the knee.

d. **Patella**- knee-cap, protects knee.

3. **Ankle—Tarsal** bones—fourteen, irregular, small bones, one larger than the rest, forming the heel.

4. **Foot—Metatarsals**—ten, forming the instep, each bearing a toe.

5. **Toe—Phalanges**—twenty-eight—big toe has two, all the others, three.

VII. **Shape.**

A. **Long** bones—hollow shaft with two enlarged ends as those of the leg and arm, giving quick motion to the body for long distances.

B. **Short** bones—seen in ankle, wrist, and vertebrae, giving strength and free, easy motion through short distances.

C. **Cylindrical**—used to support the body; as bones of arms, legs, collar-bone.

D. **Flat**—to protect organs, to afford surface to which muscles may be attached: as cranium, sternum, pelvis, shoulder-blade, ribs.

E. **Irregular** - different uses—vertebrae, etc.

VIII. **Composition.**

A. **Animal matter** which makes them tough.

B. **Mineral matter** which makes them stiff and rigid, mainly phosphate and carbonate lime.

Either may be removed and the bone retain its shape. The proportion of each varies—bones of old people contain more mineral matter, and so break easily; while the bones of children contain more animal matter, so are soft and bend easily.

IX. **Structure.**

A. **Periosteum**—outer layer made up of thin, connective tissue, through which is carried the blood which is used in making new bone.

B. **Hard Bone**—which seems solid, but which really contains canals for the entrance of blood-vessels bringing nourishment to the bones. This is a thin outer layer on all bones except in long bones, it forms the main part of the shaft.

C. **Spongy Bone**—which is filled with cavities like pores of a sponge.

D. **Cavities.**

a. Spongy bone—small.

b. Long bone—large—to give lightness and strength. Long bones have a hollow cavity running down the center.

The cavities are filled with marrow containing fat, nerves, blood-vessels and connective tissue. In the *long bone* the marrow is yellow because of the *fat*. In the *spongy bone* the marrow is *red* because of the *blood*.

X. **Joint**—place where two bones come together.

A. **Classes.**

1. **Movable**—as joints of shoulder and hip.

a. **Ball and Socket** - The rounded head of one bone fits into the hollow of the other bone - allowing motion freely in all directions—joining of arm and shoulder—leg and pelvis.

b. **Hinge**—Allowing motion in two opposite directions—joint at knee and elbow.

c. **Gliding**—Where bones slide over one another, allowing motion through very small space; joining of wrist and ankle-bones.

d. **Pivot**—Joining of ulna and radius at the elbow-axis and atlas (neck).

2. **Immovable Joints.**

a. **Sutures** - dovetailed joints.

b. **Symphyses** - smooth edges pressed together.

3. Another form of joint cartilage bands is found between the sternum and ribs and between the vertebrae of the spine.

B. **Structure.**

1. **Ligaments**—tough, fibrous, connective tissue to hold the bones in place.

2. **Cartilage**—smooth, white substances covering the ends of the bones to prevent friction.

3. **Synovial fluid** - secreted in the thin membrane inside of the ligament to lubricate the joint.

XI. **Injuries and Diseases of the Bones.**

A. **Strain**—injury due to stretching or a tearing away of the ligaments from the bone by bending a joint too much or pushing the end of a bone to one side. It is usually followed by swelling, inflammation, and pain.

Sprain - is a severe strain.—Wrist and ankle are most apt to be sprained.

If a ligament gets much of a strain, the blood and lymph-vessels are injured, causing their contents to gather about the sprain, producing a swelling. The torn ligament is kept away from the bone to which it must become again attached. Pressure on the nerves is also caused.

1. **Treatment**—Pour cold water on the sprained part, keeping the lymph from the injured parts, and making the capillaries contract, thus keeping the arteries from sending so much blood there. Hold the injured part as high as possible so the flow will be from the joint. Alternate very hot and cold applications. After a time the blood flows to the sprain and then circulation must be kept up by rubbing the swollen part towards the heart, thus aiding the veins to carry off the blood and lymph.

2. **Bandaging**—before bandaging the whole joint lightly and not above the injury, put wads of cotton held in place by a light bandage over the soft parts, as these fill with blood and lymph. Change every day, rubbing and massaging gently to keep up the circulation and prevent stiffness. This is better than entire rest, unless the ligaments are torn.

B. **Dislocated Bones**—a bone of a joint forced out of place, the ligaments becoming very stretched and sometimes torn. This occurs often at the knee or the shoulder.

1. **Treatment**—Physician usually needed. Strong pull will sometimes put the bones in place, which snap as they come together. If kept long enough together, new bone material is produced and the ends unite. This takes a long time in older people, as their bones contain less animal matter than those of children.

C. **Fracture**—breaking of a bone, thereby injuring the periosteum, tissue, nerves, and blood-vessels.

1. **Treatment**—Physician—Place two ends of the bone together and bind firmly in place with splints or in a plaster cast.

While waiting for a physician see that

a. the bone is kept in a natural position.

b. the sharp ends do not injure the muscle or fracture the tissue.

c. that the injured part is laid on a pillow or something soft.

d. that pieces of wood or something stiff are bandaged on each side to keep it in position.

e. if the person has to be lifted, do not allow the part of the body injured to be bent.

D. Young children have a very small amount of lime in their bones, so they are soft and easily affected by pressure or improper positions. Round shoulders remedied by exercises.

Do not allow a

1. baby to stand up or walk too soon.
2. child to lift or carry too heavy loads.
3. child to do too heavy work.
4. child to carry anything always on the same side or in the same hand.
5. tight clothing.
6. stooping over desks.
7. sitting on one side.

Always sit erect and stand squarely on both feet. Distribute the weight equally; raise the chest and extend it on a line with the toes, pull in the abdomen, hold head erect and chin in, keeping the ears, shoulders and hips on a straight line.

E. **Rickets**—disease of the bone, due to the lack of hardening of the bone, caused by insufficient lime-salts.

F. **Bunions**—pressure on the joints, causing injury of the ligaments and tissue.

G. **Felon**—is an inflammation of the periosteum, caused by a germ finding entrance and developing.

H. **Rheumatism**—inflammation of the synovial membrane, causing too great a flow of that liquid.

I. **Gout**—waste matter accumulated in the synovial membrane and cartilage.

J. **Tuberculosis of the Bone**—Bacteria in the joint, producing swelling and a discharge of yellow matter, weakening the vitality and strength.

It may enter the system by drinking milk from diseased cows, or from being in contact with persons who have consumption. If taken in time, persons suffering from it may be cured by good food and fresh air. (See Tuberculosis, page 15).

K. **Ankylosis of Joints**—due to too much lime in the bones, which collects in the joints uniting the bones, making them immovable.

XII. **Narcotics.**

Alcoholic drinks and tobacco arrest digestion and so prevent a proper food-supply reaching the bones. The cells that build the bones, if stupified in the least, do not take the food from the blood properly.

MUSCULAR SYSTEM

This is made up of more than 500 muscles, which form the lean meat of the body. They are made of tissue composed of large, active cells.

I. **Purpose.**

A. To move the body.

B. To protect the internal organs by uniting with the bones in enclosing the different cavities and to protect the blood-vessels and nerves.

C. To aid ligaments to fasten together bones at the joints.

D. To give beauty and form to the body.

E. To press on the veins and lymphatics so as to move the contents.

II. **Composition.**

A. Water 75%.

B. Proteid, main part of the rest, together with a small quantity of the following:

1. Carbohydrates
2. Enzymes
3. Fats.
4. Salts.
5. Nitrogenous waste (small quantity).
6. Organic acids.
7. Pigments.

III. **Classes.**

A. Voluntary—those controlled by the will, as those of the arm, leg, etc.

Four hundred in number, reddish-pink in color, covered by a transparent, glistening sheath attached to the bones at certain places. In between the fibres of the muscles are arteries, capillaries, and veins.

B. Involuntary—those not controlled by the will, but controlled by the sympathetic nervous system, as those of the blood vessels, heart, digestive organs.

C. Some are both *voluntary* and *involuntary*, as those that close the eyelids.

IV. **Structure**—Classification.

A. **Striated**—(most are voluntary).

1. Kinds.

a. Bellied Muscles—enlarged in the center and tapering at each end into one or more tendons; as of arms, legs, hands, etc.

(Tendon—white, non-elastic cord attaching the muscles to the bone that is to be moved by it).

1. Biceps—bellied muscles having two tendons at one end.
2. Triceps—those having three tendons.

3. Digastric Muscle—two enlargements connected by tendons and having tendons at each end.

b. Flat Muscles—flat and uniformly thick and attached directly to the bone without tendons, as those of the chest.

2. Structure.

a. Perimysium—thin, transparent, glistening sheath of connective tissue, which fuses into the tendons.

b. Spindle-shaped fibres placed lengthwise close together, tapering to a point. The ends fitting in between the ends of others. Surrounding each fibre are bands, one narrow and dark and one broad and bright. These fibres are covered with connective tissue, which forms a framework for the muscle. Each fibre is a composite muscle-cell, which has great power of contracting.

B. **Non-Striated** (Involuntary).

Masses of single spindle-shaped cells having no tendons, but held together by interlacing connective tissue, covering cavities. There are no cross-bands, and they contain blood vessels.

C. **Heart-Muscle.**

Tissue which is between the above two. It has not distinctive cross bands, is made of single cells branched to form a mesh. It contracts less than the first and more than the second and with a rhythmic motion.

V. **Classification according to Action**—usually arranged in pairs.

A. Flexors—those that bend the limb at the joint.

B. Extensors—those that straighten or extend the limb.

Forearm illustrates the above, flexing and extending by contracting and relaxing the two muscles.

C. Abductors—those that pull the limb outward.

D. Adductors—those that work oppositely to abduction; as the muscles of chest when drawing the arm across the chest.

E. Sphincters—those that are ring-like and surround openings; as of the mouth, etc.

VI. **Food.**

Lymph } Brought by blood vessels, which also carry away the waste and
Oxygen } carbon dioxide.

VII. **Exercise** is necessary for the health of the muscles. If they are not exercised, they become soft, and lose their elasticity. The circulation is retarded, thus preventing the proper amount of food and oxygen from reaching the muscles. The exercise should be regular, but should not be taken immediately after eating, as the blood is needed for digestion. Walking exercises body, legs, arms, lungs and heart. Rowing, swimming, and running are other forms of good exercise for developing the lungs and stimulating circulation.

VIII. **Effect of Alcohol and Tobacco.**

They weaken the muscles by affecting the nerve-centers, which control the muscles. The total amount of work done is less when stimulants are indulged in, though there seems to be an increase at first.

IX. Cramp in Leg—muscles contract into a knot—rub briskly and stretch heel out and away as far as possible.

Epileptic Fits - patient unable to control movement of arms and legs. No remedy, put something between teeth to prevent tongue being bitten and treat as for fainting. If child, give emetic and cathartic.

CIRCULATORY SYSTEM

Blood vessels and their contents—*blood.*

I. **Organs.**

A. Heart, which pumps blood.

B. Blood vessels.

1. Arteries—carrying blood *from* the heart.
2. Veins—carrying blood back *to* the heart.
3. Capillaries—connecting the veins and arteries.

II. **Blood**—Quantity—about six quarts in a full grown person.

A. **Composition of Blood.**

Blood is a tissue made up of a watery, yellowish liquid, called plasma, 90%; a number of cells without a nucleus, which are called red corpuscles; and some cells with a nucleus called white corpuscles.

1. **Plasma** is a sticky substance containing a small amount of mineral matter. Use—to hold some waste material and digested food. It filters through the capillaries, bathing and supplying the tissues with food. This escaped **plasma** is called lymph, the middleman between the cells and the blood.

2. **Red Corpuscles** are so tiny that there are over four millions in a drop of blood or in one cubic millimeter. When magnified they look to be the shape of a coin, with the flat surface slightly hollow. They are clear and transparent; of a yellowish-red color, but in great mass look deep scarlet. They carry air from the lungs to the tissues and remove a small quantity of carbon dioxide.

3. **White Corpuscles** are slightly larger and less numerous than the red corpuscles, only 5000—7000 to one cubic millimeter. They are spherical and white in color. They have a peculiar habit of changing shapes.

Use.—a. To eat disease germs.
b. To aid the villi in absorbing food from the intestines.
c. To help to form clots of blood.

B. **Why Circulation is necessary**—Use of Blood.

1. To distribute oxygen to the tissues.
2. To distribute heat and so equalize the temperature of the body.
3. To help to distribute food to the body, which by absorption has reached the plasma, after being digested.
4. To carry away waste material—(carbon dioxide to the lungs, urea to the kidneys, acids to the skin) to those organs used to remove them from the body.

C. **Temperature** of Blood is the average temperature of the body, and when normal is about 98° F. If it continues over 100° for a length of time, it indicates fever.

D. **Lymphatics**—consist of lymph capillaries and lacteals. The lymphatics carry waste from the tissues of the body and drain it off in to the veins, back to the blood again. Muscular exercise aids the flow of lymph. If it is allowed to accumulate in spaces and is not drained off, it causes the body to swell, as in case of *dropsy.* (See p. 9. F. Lymph).

E. **Hygiene.**

1. Fresh air to secure oxygen.
2. Sleep to save tissue, and so not tax the blood too much.
3. Exercise to aid in distributing food and oxygen and in carrying away waste.
4. Nutritious food for plasma and red corpuscles.

III. **Heart.**

A. **Location**—in the chest-cavity above the diaphragm and behind the lower two-thirds of the breast-bone, the smaller end slightly below and to the left of the breast-bone.

B. **Shape and Size**—cone-shaped—about the size of a pear.

C. **Structure**—It is an involuntary muscular sac, surrounded by a tough membrane, the PERICARDIUM. The muscular wall contains nerves, blood-vessels, and connective tissue. It is hollow and divided into four cavities.

1. **Auricles**—two upper, thin-walled.
2. **Ventricles**—two lower, thick-walled.

The two cavities on the right are connected, as are those on the left, but there is no communication between the right and left side.

D. **Work of the Heart** is to help circulate the blood. This is done by contracting and expanding. When it contracts, the blood is squeezed out, and when it expands, the blood is sent in. This contracting and expanding make a peculiar sound, which we call the BEATING—*both sides work in unison.*

E. **Rate**—72 beats per minute—normal.

F. **Course of Blood**—Veins finally unite into two large veins, the superior and inferior venae cavae, which enter the right auricle. When this is full, the pressure forces the triscupid valve open, permitting the blood to flow through into the right ventricle, but not to return. This in turn contracts and forces the blood through the semilunar valve into the large pulmonary artery, which carries it to the capillaries of the lungs, where it is purified, receiving oxygen. Then, by four veins, the right and left pulmonary veins, the pure blood is brought to the left auricle, which contracts and forces it through the mitral valve to the left ventricle. This in turn contracts and forces it through the semi-lunar valve into a large artery, the aorta, which distributes it over the body. In the tissues the arteries divide and subdivide into capillaries and these collect into veins, which unite into two great veins, bringing the blood back to the heart. (See p. 13.—5. Exhaled Air).

IV. **Blood vessels.**

A. **Arteries**—carry blood *away* from the heart. These large blood-vessels are placed farther below the surface than the veins. They have tough, elastic walls, which are supplied with a muscular layer to enable them to contract and expand. They contain much oxygen and little carbon dioxide, and so are bright-red. Blood moves in spurts.

B. **Veins**--carry blood *toward* the heart. Their walls are less muscular, slightly thinner and more elastic than the walls of the arteries and are placed nearer the surface. They contain much carbon dioxide and little oxygen, so the blood is dark in color and through the skin looks blue. Veins have valves. Blood moves in a steady stream.

C. **Capillaries**—tiny tubes, connecting arteries and veins and so numerous that they form a fine network throughout the body. The pink or red color of the skin is due to the blood in this fine network of capillaries. The walls are so thin that as the slowly flowing blood passes through the tubes, the oxygen and the plasma carrying the digested food, can soak through the walls and enter the tissues, and the carbon dioxide can pass from the tissues into the capillaries.

D. **Arterial Blood**—blood found in the arteries is bright-red in color, due to much oxygen. It also contains much digested food.

E. **Venous Blood**—blood found in the veins is dark-red in color and contains little oxygen and digested food, but is rich in carbon dioxide and other waste material.

F. **Lymph**—is a watery liquid found in the tissues and is composed of plasma, unused food, oxygen, and waste material (watery liquid in blister). (See page 8, D. Lymphatics. See page 20, XVI).

1. HOW FORMED—it is formed by the plasma, the blood oozing through the capillary walls and entering the tissues. With this mixes carbon and other products given off by the tissues.

2. How removed—it is removed through a set of tubes called the lymphatics. These tubes begin in spaces in the tissues and form a network of tubes through the body, which conduct lymph to the veins near the heart. It must be removed from the tissues in order to carry away useless and poisonous materials.

3. Lymph-Glands—in the lymphatic tubes are enlarged spaces of a spongy structure, called lymph-glands. Here the white corpuscles are formed and disease-germs destroyed.

G. **Pulse**—is the throbbing produced by the heart and is felt in any artery that lies near the skin. Each time the heart contracts, a fresh supply of blood is sent into the arteries. This causes the arteries to swell out. As the heart expands, the pressure decreases in the arteries and they grow smaller. Again, as the heart contracts, they swell out, and thus a beating or throbbing is caused, which tells whether the heart-beat is strong or weak and how fast it beats.

H. **Clotted Blood.**—As the blood flows out after an injury, it thickens around the blood-vessel that has been injured.

1. How and why it forms.—The blood is made to clot because the sticky substance in the plasma, when a blood vessel is injured, forms into a mass of tangled threads. The thickened jelly-like corpuscles are held by these threads forming the clot.

2. Use—prevents bleeding to death.

I. **Food** is taken into the blood for nourishment, as follows:

1. *Lacteals*—take fats.

2. *Capillaries* of *stomach* and *intestines* take all other food and pass it to the liver, where the carbohydrates are stored in the liver or sent out into the veins into general circulation.

3. *Lungs*—take oxygen.

Waste—carbon dioxide, urea, etc., is taken into the blood collected from tissues by the capillaries and lymphatics.

1. Lungs—carbon dioxide.
2. Kidneys and skin—urea and other waste.
3. Large intestines—faeces.

V. **Injuries or Disturbances.**

A. **Bruises.**—Whenever an injury occurs, so that the blood vessels under the skin are broken open and the blood flows out, a clot is formed under the skin, making a black and blue spot. The formation of this clot may be prevented sometimes by tightly bandaging the injury with very cold compresses.

B. **Hemorrhage**—this is a discharge of blood from a blood vessel, especially an injured one. From an artery the blood flows so rapidly that as soon as a clot is formed, it is washed away, so without assistance a person would bleed to death.

When a large artery is cut, the blood may be stopped by tying a bandage on the side toward the heart. When a vein is cut, the flow of blood may be stopped by tying a bandage on the side away from the heart.

Nose-Bleed—patient kept erect, put cracked ice on the back of the neck and between the shoulders. Hold nose shut and breathe through the mouth.

C. **Fainting**—is caused by insufficient amount of blood in the brain. To revive a person

1. Lay the person flat down, with head lower than feet, if possible.
2. Open windows to admit fresh air.
3. Loosen tight clothing, especially about the neck.
4. Hold near the nose camphor or ammonia on a cloth.
5. Rub the wrists and temples.
6. When able to swallow, give sips of hot water and aromatic spirits of ammonia.

7. If a person feels faint, drop the head between the knees; this will prevent fainting.

D. **Anemia**—is a poor condition of the blood, due to an insufficient amount of red corpuscles. It is indicated by the pallor of the skin and lymph. In children it is frequently due to

1. Insufficient supply of food.
2. Improper food.
3. Not enough air.
4. Not enough sleep.
5. Too rapid development.
6. Not enough outdoor exercise.

E. **Palpitation** of the Heart—rapid and irregular beating of the heart, sometimes caused by indigestion.

F. **Apoplexy**—bursting of a blood vessel in the brain.

G. **Chilblains**—due to poor circulation in feet—rub feet with ointment, wear loose shoes, and change stockings frequently during the week.

VI. **Value of Exercise.**

A. It makes the tissues work faster, so they require more food and oxygen to supply the worn-out parts. This necessitates more blood, as the breathing is faster and the heart beats faster to hasten the blood to the tissues to supply the needed food and oxygen. The lymph must flow faster to bathe the tissues so they can take out food and oxygen and pass into the lymph the waste materials that the lymph and blood remove. If the blood and lymph do not flow fast enough, the tissues are unable to get rid of their waste materials or get materials for repair, hence the body is filled with waste, which causes a dull, stupid feeling, and fatigue.

VII. **Effect of Alcohol.**

A. Acts on the nerve-centers, which affect the nerves of the arteries, causing the arteries to force an undue amount of blood to the capillaries, distending the walls.

B. If too much is taken, the cells of the tissues are destroyed.

C. It brings the heat of the body to the surface, so producing a sensation of warmth, but this heat escapes and soon lowers the temperature of the body.

D. Hardens the arteries.

E. Causes fatty degeneration of the heart.

Spleen—use not known, though probably connected with digestion, as it enlarges after digestion. It is dark-red, 1 by 4 by 5 inches, found on the left side, partly covered by the ribs. It has no opening, so its product must pass directly into the blood. It is something like a lymphatic gland, so may help make some white corpuscles.

RESPIRATORY SYSTEM

I. The **organs** which supply oxygen to the cells and remove carbon dioxide, make up the *respiratory system.* It consists of important air-passages, the *nose*, *throat* or *pharynx*, *larynx*, *trachea* or *wind-pipe*, *bronchial tubes of the lungs.*

II. **Nose.**—It is composed of two passages, opening at the upper and back part of mouth and outward at the end of the nostrils, separated by a partition of bone and cartilage. It is lined with mucous membrane, which secretes MUCUS, a slimy, watery liquid which becomes thick and stringy when recovering from a cold. This mucus destroys germs, keeping the membrane clean. There are numerous hairs, called CILIA, which prevent dust and germs from entering the throat. The air is also warmed before entering the throat by the numerous blood vessels lining the membrane, so the air breathed in should pass through the nose instead of the mouth. The nerves of smell are found in the mucous membrane of the upper passage. The tear-duct runs into the nasal cavity, and so the tears constantly secreted are carried off instead of running down the cheek.

III. **Pharynx.**—It is the throat leading up to the nose and down to the larynx or wind-pipe, and to the aesophagus or gullet (food-pipe). It is conical in shape, about five inches long. It is back of the mouth, separated from the mouth by the *soft palate*, which forms the roof and from which hangs a finger-like projection called the UVULA. In front of this is the *hard palate* or the *roof of the mouth.* The pharynx is connected with each ear by a tube called the *eustachian tube* entering the middle ear. On each side of the root of the tongue is an oval projection, about one inch long, called the TONSIL, whose use is not known. (See page 18).

IV. **Larynx**—voice-box. Cartilagenous box, located in the front of the neck, connecting with the throat just back of the tongue. The projection made by larynx on the throat is called *Adam's Apple.* The upper part of the larynx is covered by the *epiglottis*, a lid which closes when we swallow food, but remains open at other times to allow air to pass.

A. **Vocal Cords** are ligament folds of membrane attached to the larynx. When these cords are stretched tightly, the opening between them is small, so the air coming from the lungs causes them to vibrate and produce the *voice.* If the voice is modified by the tongue, teeth, and lips, etc., *speech* is produced.

1. **Pitch** of the voice depends on the number of vibrations per second. Vocal cords are long in men, so their voices are lower and coarser than a woman's voice.

2. **Hoarseness** is caused by the swelling of the vocal cords, due to the collecting of the blood and lymph because of cold or overuse.

V. **Trachea or Wind-pipe and Bronchi.**

Wind-pipe is a short tube, about four inches long, slightly larger than the finger and reaching from the larynx to the center of the chest, where it divides into two *bronchi*, which branch out and lead to each lung. The wind-pipe and bronchi, as well as the air-tubes of the lungs, are stiffened with rings of cartilage which hold the tubes open, thus keeping a free passage for the air.

VI. **Lungs**—two.

A. **Location**—in the chest cavity, back of the collar-bone, extending down till they touch the diaphragm, with the heart between them. They are pinkish, spongy organs, made of a mass of air-tubes and air-cells, branching from the two bronchi and enveloped by blood vessels, nerves, connective tissue, and air-sacs. The whole lung is covered by a transparent membrane called the **pleura,** which reaches to the bronchi, then turns back and lines the chest-cavity.

B. **Use of Lungs.**

1. To receive air and permit the oxygen to pass to the blood.

2. To receive carbon dioxide and impurities from the blood and to help to exhale them.

C. **Air-cells** are air-spaces having very thin walls of tissue covered with blood capillaries, so the oxygen breathed in reaches the blood and the carbon dioxide passes out into the air-cells.

D. **Breathing**—is the constant change of the air in these cells.

1. **Inspiration**—the act of drawing in the air.

2. **Expiration**—the act of expelling the air.

3. **Respiration**—the act of moving the air in and out.

4. **Rate** of breathing—about fifteen to eighteen times per minute, while it is slower in sleep and faster during violent exercise.

Diaphragm is a sheet of muscle that forms the floor of the chest cavity. It is attached to the ribs and has a convex surface.

5. **Inhaling and Exhaling.**—In *inhaling* the ribs move upward and outward, the diaphragm flattens, the chest cavity becomes larger, and the air flows into the lungs, swelling them out to fill the chest cavity. In *exhaling* the ribs move down.

ward, the diaphragm curves upward, making the chest smaller, so the air is squeezed out of the lungs.

Exhaled air—is warmer than inhaled air. It contain less oxygen and more carbon dioxide, water, vapor, and impurities. Impurities exhaled from the lungs come from the blood. As the blood flows through the capillaries of the tissues, it receives carbon dioxide and impurities, thus changing to venous blood. This venous blood is sent to the lungs. In the lungs the impurities, carbon dioxide and water-vapor pass out through the thin walls of the capillaries and get into the air-cells of the lungs where they are exhaled. (See page 9—F. Course of Blood).

6. **Artificial Breathing.**

If for any reason a person stops breathing, turn the patient face downward, place an elevation of some kind under the chest and upper abdomen, and, standing astride over the patient, place hands on both sides over the lowest ribs; by pressing slowly, the air is driven out gradually, by reducing the pressure without moving the hands, the air is drawn into the lungs. This should be done a dozen times a minute. Sometimes a half hour is needed to establish normal breathing. Then turn the body face up, grasp arms above elbow and raise them above the head; then pull them gently to the sides, pressing the chest to expel the air or water from the lungs, keeping the tongue well drawn out. A pink color will appear on the lips and under the finger-nails.

Drowning—While one is giving artificial breathing, others should get dry blankets and hot-water bottles, and rub the legs and arms of the patient. Do not force the patient to drink till breathing is restored, then a few drops of whiskey in water or hot coffee given frequently is beneficial.

E. **Use of Oxygen.**

1. When it combines with food, tissue is formed.

2. It helps to produce heat in the body. Heat is produced when oxygen and food are combined, forming tissue. This in the body may be compared to the burning of any substance outside the body. Coal or wood burns when it combines with oxygen. As a result of this burning, a condition of heat is produced, also certain waste materials are formed, smoke or ashes. In our bodies a condition of heat is produced; the carbon dioxide and water-vapor formed are two of the substances found in smoke, and the other waste materials may be compared to the ashes. Carbon dioxide, therefore, is formed all through the tissues as a waste product given off when tissue is built.

F. **Exercise of the Lungs.**

In ordinary breathing many cells are not used to the fullest extent, and so disease germs are apt to grow. Filling the lungs with air a few minutes several times a day, causes lymph with its impurities to pass into the blood for purification by the lungs and kidneys. When the lungs are full of air, beat the chest lightly, this with arm movements, corrects round shoulders, weak back and muscles, and enlarges the chest.

VII. **Ventilation.**

It is necessary to renew the air in the rooms frequently as the lungs are using up the oxygen, breathing it in and exhaling a poisonous gas, carbon dioxide. Dullness, headache, difficult breathing indicate a need of change of air. During sleep more oxygen is needed than when awake, as worn-out tissues are then renewed. Warm air is light and rises, while cold air is heavy and is found near the floor—windows open at the top and bottom on same side of room produce a circulation of air, which soon changes entirely the air in the room. Air may go in and out through the same opening, but the carbon dioxide is heavy, sinks and goes out through the bottom, so the opening should be near the floor.

A. Effects of Insufficient or Improper Heating.

The greater the difference in temperature between the outside and inside air, the more rapidly the current of air moves in the room, so we can get along with much smaller openings in winter than in summer. Avoid draughts, for the sudden chilling of any part of the body produces cold.

When the skin is suddenly chilled, the blood vessels of the mucous membrane become filled with blood. If the membrane in this condition is infected with bacteria, inflammation results, producing cold in the head, sore throat, cold in the chest, bronchitis, or pneumonia, depending on which passage is affected. All are accompanied by a secretion of mucus which clogs the passage, making breathing difficult.

An overheated room is unhealthy, because a large amount of blood is brought to the surface and this heat is lost upon going into the outside air, chilling the body before the blood supply can be cut off. It also dries the mucous membrane, causing inflammation.

Cold rooms are also unhealthy, as too much bodily heat is lost. During cold weather the head should be protected by a night-cap, especially if subject to throat trouble or catarrh.

The air at the floor is very much colder than that a little above, so care should be taken in permitting children to play on the floor in cold weather.

Mountain air is rare and so the lungs must be exercised more to get the necessary amount of oxygen for the tissues.

Pure air is one of the three greatest preventives of disease.

Quantity—Each person should have three thousand cubic feet of fresh air every hour. Ten per cent. of oxygen is all that is necessary for the body. Sixty-eight to seventy degrees Fahrenheit is a good temperature.

B. **Kinds of Ventilation.**

1. *Natural.*
2. *Artificial*, by extracting bad air or by propelling pure air into the room.

C. **Composition of the Air.**

1 part oxygen } not combined so the blood can take only the oxygen.
4 parts nitrogen }

D. **Changes from Respiration**—The air breathed out has oxygen combined with carbon, making carbon dioxide. Nitrogen passes in and out without any changes—(eighty parts nitrogen, sixteen oxygen, and four carbon dioxide). Germs are found in all inspired air, but not in expired air, except with sneezing and coughing, then many germs are thrown out, otherwise they cling to the moist mucous membrane.

VIII. **Tight clothing affects**—

A *Breathing* by hindering respiration, as the lungs cannot be easily filled with air unless the diaphragm and ribs move freely.

B. *Circulation* of the blood, as it is stopped to a certain degree.

C. *Internal organs*, as they are pressed out of place.

IX. **Disturbances of Breathing.**

A. **Short Breath, due to**—

1. Heart disease.
2. Tuberculosis having destroyed part of the lung tissue.

B. **Asthma**—loss of breath due to the contraction of the muscles of the air-tubes shutting off the air from the air-cells.

C. **Suffocation**—air cut off from the lungs.

D. Reflex movements, taking place without any will on our part, but most can be controlled to a certain extent.

1. **Sneezing**—forced expiration in which the air passes through the nose.
2. **Laughing, crying, sobbing,** short expiration followed by long inspiration.
3. **Hiccoughing**—sudden inspiration, due to quick contraction of the diaphragm. Stick finger in each ear and drink water in glass held by some one else.

Push tongue out and hold it. Spoonful of dry sugar in the mouth sometimes stops it. Sneezing stops it.

4. **Coughing**—forced expiration in which the larynx is suddenly opened wide.

5. **Snoring**—inspiration so that the air passes through both the nose and the mouth, causing the soft palate to move back and forth.

6. **Whistling**—inspiration or expiration, with the lips held in position to vibrate the air in the mouth.

7. **Yawning**—long inspiration or expiration through open mouth, while throat muscles are held rigid.

8. **Choking**—If a child, hold by his feet, head hanging down, and strike chest a couple of blows. If an adult, strike a blow between the shoulder-blades. If the object swallowed is hard, eat hard, dry bread, crackers, and potatoes, so the jagged edges will not injure the intestines.

X. **Diseases of the Air Passages.**

A. Cold, sore throat, diphtheria, tonsilitis, pneumonia, pulmonary tuberculosis, asthma, bronchitis, catarrh, pleurisy.

B. **Diphtheria, Membranous Croup,** and **La Grippe** are germ diseases, produced by a special kind of bacteria in the throat.

C. **Pleurisy**—inflammation of the pleura, caused by growth of germs on the membrane or by two surfaces rubbing together, producing pain. If the secretion of the liquids increases to an abnormal amount and so presses on the lungs, it will have to be drawn, by tapping the cavity.

D. **Hemorrhage** from the lungs—cracked ice on chest and take cracked ice.

XI. **Consumption or Tuberculosis.**

A. **Various names it is known by—**

1. *Consumption* or *phthisis*, when in lungs.
2. *Hip disease*—in bone.
3. *Meningitis*—in brain or spinal cord.
4. *Lupus*—in skin.
5. *Scrofula*—lymphatic glands.

B. **Symptoms of Consumption.**

1. Cough (sometimes not present at first).
2. Loss of weight, strength, and vitality.
3. Fever.
4. Spitting of blood (sometimes).
5. Sweats at night.

C. **How to prevent its spreading.**

1. Consumptives should spit in a cloth or paper that can be burned. Always cover the nose or mouth with a cloth or paper when sneezing or coughing. Never cough, sneeze, or breathe into another's face. Do not spit on the floors or sidewalks.

2. Hands and face must be kept clean. Consumptives should sleep alone in a room, not one occupied by others. Dishes used by consumptives should be sterilized by boiling immediately after using and should not be used by others. Food removed from a consumptive's plate or room should never be eaten by others. All clothing worn or used about consumptives should be thoroughly boiled or disinfected before placing it with other clothing.

D. **How to Cure Consumption.**

1. Sleeping and living in the open air. Any climate will do as long as it is not contaminated by people or animals. It is not necessary to go to the mountains; every state has made its cures.

2. Eating an abundance of milk, eggs, meat, brown bread, and other nutritious foods.

3. Keeping the body strong and free from other diseases.

4. If the patient has fever, there should be absolute rest, to prevent the poison passing through the body, but to have it instead thrown off in sputum. Light exercise, when there is no fever, and pleasant surroundings.

5. Sputum should not be swallowed, as other parts may be thus infected.

6. Drugs and medicines will not cure consumption.

E. **Health Rules.**

1. Good Air—Avoid badly ventilated, badly lighted, dusty, overheated or damp rooms.

2. Pure Water—Drink pure water. If in doubt, boil the water. Avoid public drinking-cups.

3. Safe Milk—Tuberculosis, typhoid fever, and other diseases are often caused by drinking raw milk. Get milk properly pasteurized or pasteurize it at home, or simply scald it.

4. Keep Clean—Take a bath or sponge daily, and a warm bath followed by a cold shower, once or twice a week, or oftener. Use soap freely. Wash the hands before handling food. Do not put fingers, money, paper, or pencils into the mouth. Do not bite the fingernails. Clean your teeth morning and evening.

5. Food—Don't eat raw food, that has been exposed to flies or dust, or touched by unclean hands, without first washing it. Chew your food well.

6. Sleep—Get enough sleep. Sleep with windows open, or, better still, outdoors.

7. Head Up—Sit and stand erect. Practice deep breathing, and breathe through the nose.

8. Exercise—Take plenty of outdoor exercise, but avoid excess in athletics; it may cause heart trouble. Do not eat or drink when overheated by exercise.

9. Do not neglect Colds—If not cured soon, go to a doctor or dispensary for treatment.

10. Sunshine—Admit plenty sunshine into the house and into your life, as mind acts on the body.

XII. **Adenoids**—spongy growths found in the back of the nose and upper throat.

Effects—

1. When very large, they stop up the nasal passage, thereby producing mouth-breathing, giving rise to enlarged tonsils, diphtheria, sore throat, etc.

2. They prevent the body from receiving a sufficient amount of oxygen and from getting rid of carbon dioxide.

3. Cause eye-trouble and headache.

4. Produce deafness.

5 Delay mental development of child because of insufficient air.

6. The physical development of a child is interrupted and the child becomes anemic.

XIII. **Tobacco**—The heat and gases from smoking dry the mucous membrane, and so irritate the air-passages. In the lungs the poison reaches the blood. It decreases the lung capacity. Cigarette-smokers inhale smoke into the lungs; therefore, this is a more dangerous form of smoking than that of cigars or pipes, as the smoke is seldom inhaled from them.

Alcohol lessens the rate and depth of breathing.

DIGESTIVE SYSTEM

I. **Digestion**—the process of changing food, so that it may enter the blood and so feed the cells.

II. **Gland**—collection of cells, whose special duty it is to give off a certain kind of secretion. Simple gland-cells are arranged to form a hollow tube, those on the out-

side taking water and other material from the blood, while those on the inside give out a liquid secretion into the hollow.

III. **Organs** of **Digestion.**

A. Alimentary Canal.

1. Mouth { Teeth. / Salivary Glands.
2. Pharynx.
3. Aesophagus.
4. Stomach.
5. Small and large intestines.

B. Liver.

C. Pancreas.

IV. **Alimentary Canal**—long passage through the body, into which the food is taken while being digested. Its walls are made of circular and longitudinal muscles that contract and so force the food on. Lining the canal is a smooth, pinkish, mucous membrane, secreting a sticky mucus to aid the food to slip along easily. Digested food and liquids pass through the walls of the alimentary canal into the blood, and is thus carried to all parts of the body. Most of this is done from the small intestines.

V. **Mouth**—food enters the mouth, is ground to pieces by the teeth, and mixed with saliva. The tongue mixes the food with the saliva and pushes it about for chewing and swallowing. It is the center of taste and shows poor digestion by becoming coated with mucus, but in a healthy state is red. The pharynx is back of the mouth, separated from the mouth by the soft palate, which forms the roof and from which hangs a finger-like projection called the uvula. In front of this is the hard palate or roof of the mouth. An oval body, half an inch long, on either side of the root of the tongue, is the tonsil. Bacteria growing on it and other parts of the throat, transmitted by the use of a common drinking-cup, or other ways, cause tonsilitis.

VI. **Teeth.**

A. **Parts.**

1. Root—It fits in the socket of the jaw-bone and is held in place by a hard, bonelike cement.

2. Neck—the narrow part connecting the crown and root where the crown enters the gum.

3. Crown—

a. *Enamel*—outside covering—hardest material.

b. *Dentine*—bulk of the tooth, harder than bone, but much softer than enamel.

c. *Pulp Cavity*—Opening in the middle containing nerves and blood vessels, which enter through little canals through the root from the jaw-bone.

B. **Kinds of Teeth and Use.**

1. Incisors, 8—flat, sharp—used to bite and cut food.

2. Canines or Cuspids, 4—resemble the shape of dog's teeth—used to tear the food apart.

3. Bicuspids, 8—wide surface, used to grind the food and mix it with saliva.

4. Molars, 12—those of upper jaw fit into those of the lower jaw, and, in chewing, the sideways motion causes the food to be ground.

Mastication—action of teeth in grinding food.

C. **Temporary and Permanent Teeth.**

The jaws of a child are too small to hold large teeth, so they have twenty small *temporary* teeth at first, then thirty-two large *permanent* teeth.

D. **Care of teeth.**

1. Brush them well after each meal, or at least morning and night.

2. Remove food by running thread or an elastic between the teeth.

3. All cavities should be filled at once before they reach the nerves. If the enamel is broken by biting hard substances, the dentine is exposed and decay sets in.

Toothache—If a cavity—clean it out, then dip cotton in oil of cloves and push into the cavity. If the tooth is dead and sore to the touch, place an ice-bag on it to prevent inflammation. Consult a dentist.

VII. **Salivary Glands.**

A. **Kinds.**

1. Sublingual—two under the tongue.
2. Submaxillary—two under and behind the corners of the lower jaw.
3. Parotid—two in front of the ears. (Swollen and inflamed give **mumps.**)

B. **Saliva**—a clear, colorless liquid, carried from the glands to the mouth through circular canals, called ducts.

1. Use of Saliva.

a. To moisten food and so enable the swallowing of dry substances.

b. It contains the enzyme ptyalin, which digests part of the starch, changing it into sugar.

C. **Enzyme** is a chemical compound, causing chemical changes in a nutrient without being consumed itself.

VIII. **Pharynx,** or throat, receives the food from the mouth. It is conical in shape, about five inches long, just back of the mouth. It opens into the nostrils, into the two ears and into the wind-pipe and aesophagus, or gullet. The wind-pipe, or glottis, is covered by the epiglottis, which is closed during swallowing, but at other times is open to allow air to pass in breathing. The whole is lined with a mucous membrane. (See page 12).

IX. **Aesophagus,** or gullet, receives the food from the pharynx, connecting it with the stomach. It is a tube, about nine inches long, passing through the chest and diaphragm, made of a layer of muscles which contract and expand, forcing the food down. The food is not changed chemically either in the pharynx or aesophagus.

X. **Stomach**—At the end of the aesophagus is the store-house, holding about three pints, so that enough food may be eaten at one time to supply the body for some hours. Food remains in the stomach from one to four hours.

It is a bag lying under the diaphragm and across the upper part of the abdominal cavity, with the large end near the left side of the body, connecting with the aesophagus by the opening, the *cardiac orifice.* The right end of the stomach tapers to a narrow part and connects with the small intestine by the opening, the *pyloric orifice.* The whole is held in place by the *peritoneum* or lining of the abdominal cavity.

A. **Gastric Glands**—lining the inner walls of the stomach, secrete a juice two and a half quarts a day, containing water, pepsin for digesting proteids, and acids for digesting the food and killing the bacteria.

B. **Muscles**—same as in the rest of the canal, circular and longitudinal, and in addition oblique.

Use—to force the food through the stomach and lower portion and to mix the food and gastric juices.

1. Pyloric Muscle—strong ring of muscles between the stomach and small intestine. After digestion is finished this passage opens and this circular muscle forces the food through to the small intestine.

C. **Overeating**—The stomach becomes too full for proper action in revolving the food, and a poor quality and less quantity of gastric juice is secreted. This causes irritation of the nerves ending in the lining of the stomach and causes a feeling of sickness or *nausea.* If the undigested food does not pass to the intestine, vomiting follows. Headaches are prevalent with a disturbed stomach.

Fluids very hot or cold are bad, as they hinder the flow of the gastric juices.

D. **Convulsions**—due frequently to indigestible food—small children are subject to them. They are unconscious and so do not suffer. Empty the bowels, place the feet in hot water, and place cool cloths on the head.

XI. **Small Intestine.**

It is twenty-two feet long, coiled up in the abdominal cavity.

A. **Intestinal Glands**—lining the inner walls of the intestine, secrete intestinal juice to aid digestion. The juices of the liver and pancreas are emptied into the small intestine.

B. **Villi**—finger-like elevations on the intestinal wall projecting into the digested food; and, as digestion is finished, absorb most of the food and liquids, so taking it into the body through the intestinal wall, thus giving a great absorbing area.

XII. **Large Intestine.**

Its principal use is to remove indigestible material from the body. It begins on the lower right side of the abdomen, crosses under the diaphragm down the left side. Glands secrete mucus and throw off into the intestine the waste products.

Constipation—due to the failure at a regular hour daily to empty the large intestine of refuse matter.

Vermiform Appendix has no use now. It is a blind tube projecting from the large intestine where it joins the small intestine. It is as large around as a lead pencil and from one to six inches in length. The cavity is not much larger than the head of a pin in diameter. If this becomes clogged or germs grow, inflammation sets in and produces **appendicitis.**

Chyme—a milky fluid, which is found in the stomach and enters the intestine. It is an acid mixture made up of partly digested proteids, starch, undigested matter, and gastric juice.

Chyle is the alkaline mixture in the intestines after the chyme has been acted on by the bile, pancreatic and intestinal juices.

XIII. **Liver.**

It is the largest gland, weighing from three to four pounds. It is of a dark-red color and is on the right side of the abdomen, near the diaphragm, partly overlapping the stomach. It is divided into two parts, the right one being larger. It secretes bile, which is emptied from one large duct into the upper part of the small intestine.

Gall Bladder is located on the under-side of the liver. It is a pear-shaped sac for storing bile when it is not needed for digestion. When needed for digestion, the walls contract and force out into the small intestine a thick, greenish-yellow bile of bitter taste.

Jaundice—the bile gets into the blood because the bile-duct is clogged and most of the fats escape digestion.

XIV. **Pancreas.**

It is a long, tongue-shaped gland of pinkish-yellow color, lying along the curve of the stomach.

Pancreatic Juice—is a thin, watery fluid, containing

a. Trypsin—to digest the proteids.
b. Amylopsin—to digest starch.
c. Steapsin—to digest the fats (acts very quickly).

Pancreas from an animal is known as Sweetbreads.

Diabetes—incurable—certain cells in the pancreas become affected and has, as a symptom, sugar in the blood.

XV. **Nervous Control of the Digestive System.**

Mind affects digestion; sorrow, homesickness, anger, etc., arrest digestion, while a cheerful, happy mind aids it. Food should be well cooked and appetizing. (See Food, page 21).

XVI. **Lacteals** are innumerable tiny vessels coming from the villi and other parts of the intestines, uniting into tiny tubes, which in turn unite and form the thoracic duct, about the size of a quill, found in front and to one side of the spinal column, leading to the large jugular vein in the neck. The milky color of the fluid in these vessels and the absence of blood gives the name lacteal. The lacteals form part of the lymph system and return to the vein in the neck and thence to the heart, the blood constantly oozing out of the capillaries to all parts of the body.

XVII. **Absorption**—More than nine tenths of the food in the blood is absorbed by the villi or small intestines.

Each villi is a layer of cylindrical cells covering a core of blood capillaries surrounding a single vessel leading into the lacteal system. Food passes through the outer layer of cells. Fat goes to the lacteals and the other part of the food is absorbed by the blood capillaries, uniting and forming the portal system leading to the liver. Through this, all food, except fat, is sent from the villi to the liver. The final product of digestion is CHYLE, which passes into the villi by absorption. Food must be transferred from the alimentary canal, where it has been broken up and prepared for use, to the cells of the body it is to feed and repair. The transfer is done in two ways directly by the blood vessels of the stomach and intestines or by the lymphatics. The blood capillaries of the stomach and intestines fuse into one large vein, the portal vein.

In the liver the food undergoes further changes before entering that part of the circulation which supplies the tissues with food. Here poisonous matter is destroyed and eliminated. If the liver loses its power to destroy these poisons, they enter the tissue supplied by the blood and poison the body, *bilious* attacks resulting, with coated tongue, headache, dullness, loss of appetite. Medicine stimulates the liver so the bile is poured out in great quantities, carrying away the poisons.

XVIII. **Hygiene.**

Moderate amount of food should be taken daily at regular intervals. If taken to excess, the intestines become clogged and overworked, the food is not digested properly, and the poisons not removed.

Bowels should operate at regular intervals each day to remove the indigestible material in the large intestines and the poisons given off by the liver back into the intestines, otherwise constipation results. This may be often avoided by eating cornmeal mush, fruit, onions, and other vegetables, game, plenty of water, but avoiding hot bread, pastry, dried meats, cheese, boiled milk, tea, potatoes, rice.

XIX. **Alcohol and Tobacco.**

Stomach and liver are injured the most. As the greater part of the alcohol is absorbed through the stomach walls, little goes to the intestines, but it is instead absorbed by the liver, causing fatty degeneration, that is, changing to fat, so the bile cannot be secreted. It is very harmful if the stomach is empty. The hardening, due to the use of whiskey and distilled liquors, causes the cells to waste away and die, often causing death among excessive drinkers.

Alcohol in small quantities and used occasionally in case of illness, is of advantage. It stimulates the flow of gastric juices and so aids digestion, and it is itself quickly absorbed by the blood vessels, so does not remain long in the stomach. The sensitive cells, however, soon fail to respond to so slight a stimulus and the amount must be constantly increased to produce the desired effect. When taken in large amounts it retards the action of digestive fluids, injures the nerve centers and digestive organs and finally produces a dangerous habit.

Tobacco, chewing or smoking wastes the saliva, as it is spit out. It lessens appetite for food and the power of digestion.

FOOD

I. This is anything to nourish the body or to produce heat and energy.

II. **Classes.**

A. Organic.

1. Nitrogenous—proteids, albuminoids.
2. Non-nitrogenous—
   a. Carbohydrate—starches, sugar.
   b. Hydro-carbons—fats, oils.

B. Inorganic—mineral salts, water.

Proteid is composed of oxygen, hydrogen, nitrogen, carbon, sulphur and is found in nearly all animal and vegetable foods. It replaces the worn-out tissues.

Albuminoids resemble proteids in their composition, but not in their action. They are found in soups made from bone marrow.

1. Classes—
   a. Albumen.
   b. Fibrin { Animal—blood, chyle. / Vegetable—glutens, cereals.
   c. Casein { Animal—milk, cheese when coagulated. / Vegetable—legumes, peas, beans, etc.

Carbohydrates composed of carbon and two parts of hydrogen to one part of oxygen, include starches, found mainly in potatoes and corn; and the sugar found in grapes and all plant and animal tissue.

Fats composed of carbon, hydrogen, and oxygen, is found not only in fat, but all vegetable and animal oils.

Mineral Salts found in water and in all living matter.

Water found in fresh vegetable and plant foods; 59% of our own bodies is made up of water.

III. **Uses.**

A. *Furnish material for making or repairing the tissues of the body.*

1. Tissues are constantly breaking down and being built up again. This is best done by proteids and nitrogenous foods. In youth the building up exceeds the breakage and we find an increase in size and weight—in middle age the forces are about equal, while in old age the breaking down is not rebuilt as thoroughly, and power is lost until finally all action ceases and death results.

2. Vegetable foods build tissues. When cooked
   a. The flavor is improved, and
   b. It is more digestible.

B. *Produce motion, heat or both.*

1. The production of motion or heat is best accomplished by carbohydrates and fats, though proteids and albuminoids are also useful. People using their muscles a great deal require more of these foods than those who lead a less active life. Proteid is the only food that can be used both for building up tissue and for supplying energy.

2. Meats are valuable for fuel and energy. Roasted, broiled, boiled, fried—first two keep the juices; if plunged first into hot water and then boiled, the juices will also be kept. For soup put the meat in cold water and allow it to slowly come to the boiling-point. Frying is poor, as it adds grease and is less digestible.

Meat should be cooked
   a. To kill germs.
   b. To improve the flavor and appearance, and
   c. As it digests easier and in less time.

IV. **Foods.**

A. Bread eaten with butter is a perfect food.

B. Milk, a perfect food, contains all the elements for the body and is almost completely digested and absorbed; but for adults it does not contain ingredients in the proper proportion, so other food must be taken with it.

Skimmed milk is just as nourishing as milk, except that the fat has been removed.

Buttermilk is sour milk, from which the fat is removed by churning it into butter.

Pasteurization—heat milk 25 minutes at about 160 F., then cool quickly. This kills germs.

C. Cocoa, an excellent drink for children, contains fat, starch, and proteid, so is very nourishing.

D. Adulterated Foods—those mixed with a chemical or a cheaper material; as, coffee mixed with chicory.

E. Condiments are added to make food more appetizing. They increase the flow of the juices and so aid digestion, provided they are not used in excess. (Pepper, mustard, etc.)

V. **Stimulants** cause organs to act more vigorously than ordinarily; as, tea, coffee, chocolate, beef tea, and alcoholic drinks.

Beef tea contains very little nourishment. Tea and coffee should not be given to children, as they disturb digestion, produce nervousness and sleeplessness.

VI. **Alcoholic Drinks.**

A. Kinds.

1. *Wine*—5 - 25% alcohol.
2. *Malt liquors;* as beer, ale, etc., 2—5%.
3. *Distilled liquors;* as, whiskey, gin, brandy, etc., 40—50%.

B. Uses and Effects—Alcohol in small quantities is similar to fats and carbohydrates in its effect, producing fuel and energy without harming the tissues, as it is absorbed at once by the blood without any preparation. It increases the flow of digestive fluids and is often good in sickness.

But it has a stimulating effect upon the nervous system, which is very apt to lead to its excessive use, for the habit once formed demands increased amounts for stimulation, when it poisons the system, stops secretion and flow of juices, causing lack of proper digestion.

Alcohol.

1. Lowers temperature of the body.
2. Impairs muscular power.
3. Deranges digestion.
4. Diminishes sustained mental work. (See the end of each chapter).

C. Patent Medicines—most of them contain more alcohol than is found in beer or the strongest wine. They frequently contain morphine, and opium; as, Paregoric-opium, etc.

VII. **Narcotic** relieves pain and tends to produce sleep.

A. Kinds—Alcohol, tobacco, opium, hasheesh, chloroform, chloral hydrate.

B. **Tobacco**—the narcotic effect is due to the nicotine, a deadly poison, but an extremely small amount enters the system if the smoke is not inhaled. It dulls the nerves that are fatigued and produces a restfulness until the effect wears off, when the craving for more takes place, and, if yielded to constantly, results in injuring the tissues, and in the case of the young, arrests growth and development.

NERVOUS SYSTEM

I. It is that set of organs by means of which the parts of the body are made to work harmoniously and by means of which these activities are directed and controlled.

II. **Made of**

A. **Nerve cells.**

1. Simple nerve cells—spherical, microscopic, jelly-like masses, with a nucleus in the center.

2. Complex nerve cells—or *Neurons*—consist of a nerve cell and projections which prolong themselves until they are merely a fibre.

B. **Nerve Fibres or Axons.**

1. Efferent Fibres—are those nerves that carry impulses *out* from the brain, causing muscles, glands, etc., to act.

2. Afferent Fibres—are those nerves that carry impulses *in*, bringing sensation.

C. **Neuroglia**—supporting tissue.

III. **Divisions of the System** for convenience in studying:

A. **Central Nervous System or Cerebro-Spinal System**—Directing the amount of work and the time required by the various organs of the body.

B. **Sympathetic Nervous System**—Composed of bunches of cells with nerves extending to the glands and involuntary muscles of the body.

There is no true separation; the sympathetic system is a sort of branch, ruled, without our knowledge, by the cord and lower brain.

IV. **Central Nervous System.**

A. **Parts.**

1. *Brain.*
2. *Spinal cord.*
3. *Nerves—cranial* and *spinal*, extending to all parts of the body.

B. **Brain.**

1. Location—that portion of the central nervous system contained in the skull or cranium lying above and continuous with the cord.

2. Weight—about 50 ounces—smaller in women than men—$\frac{5}{6}$ of the total weight is attained by the end of the seventh year.

There is a general correspondence between the size of the brain and the intelligence.

3. Growth—in mental workers it grows until forty years of age. If it is not kept active, it stops growing at twenty years. It grows fastest in youth.

4. Exercise—brain grows by use—exercising the cells by thinking, causes the blood to flow and nourish them.

5. Composition of the brain.

a. Cortex—(thin outer layer) and other masses near the center—*gray matter* made up of *nerve cells.*

b. *White matter* made up of *fibres* found in the inner and lower parts.

6. External Appearance—The brain is much folded, thus increasing the surface without increasing the space occupied. There are fissures or dents and convolutions.

a. The *dents* are known as,

1. *Sulci*—the small ones.
2. *Fissures*—the large ones (one inch or more deep).

b. *Convolutions* are the irregular raised portions between two dents.

7. The brain is *connected* with all parts of the body by means of white cords called nerves or *axons.* Axons crossing from one side of the brain to the other,

connecting similar parts, form bands known as *commissures*, (pons varolii). The largest commissure is *corpus callosum*, joining the hemispheres of the cerebrum, others connect the lobes with each other.

(Pons—means bridge, connecting all parts of the brain).

8. Membranes.

a. *Dura mater*—this is thick, fibrous, and lines the inner surface of the bones of the skull and continues down as the outer surface of the cord.

b. *Arachnoid*—this is a delicate, transparent, serous surface fitting closely against the soft inner side of the dura mater.

c. *Pia-mater*—this is a fine network of blood vessels, which furnish nourishment and remove waste from the brain. This dips down, covering all folds and crevices of the brain.

9. Parts.

a. *Cerebrum*—forebrain.

b. *Cerebellum*—little brain.

c. *Medulla Oblongata*—lower brain.

10. **Brain** is protected from jars by

a. Curve of the foot (arch).

b. Curve of the spine.

c. Cartilages between all the joints and the bones.

d. Partial curves in the legs.

11. **Cerebrum.**

a. Location—It is the largest division of the brain and is in the fore part of the skull.

b. Use—The cortex of the cerebrum is the center of consciousness, the seat of the mind (memory, reason, will, emotion) and the various conscious sensations. It originates and sends out messages, producing voluntary action.

c. Appearance—It has many convolutions and fissures which are fairly regular and is divided into two hemispheres by means of a longitudinal fissure running almost to the base.

d. Muscular movement.

1. Centered in two convolutions; the ascending frontal, and the parietal convolutions.

2. Decussation of fibres—paralysis occurs on the opposite side of the one affected in the brain.

e. Sensory movement.

1. *Sight*—centered in the occipital lobe.

2. *Hearing*—centered in the first and second convolutions of the temporal lobe.

3. *Touch*—centered in some part of the parietal lobe.

4. *Taste*—not definitely located.

5. *Smell*—in interior of brain.

12. **Cerebellum**—This regulates and co-ordinates movements of locomotion, making the muscles act harmoniously. It is about the size of a fist. It has deep sulci and is connected with other parts of the brain by bands of nerve fibres.

13. **Medulla Oblongata.**

Prolongation of the spinal cord into the brain. If destroyed, causes instant death. It has charge of the vital functions, controlling breathing, beating of heart, processes of digestion, etc. It carries stimuli from the higher parts of the brain and acts as a reflex center for parts receiving nerves from it. (See Reflex Action, page 25).

C. **Spinal Cord.**

1. It is a prolongated mass of nerve tissue continuous from the brain to the end of the spinal column; extending through the center of the backbone or vertebrae.

2. Size—little thicker than a pencil—weight, one and a half ounces.

3. Structure.

a. *Gray matter* (cells) inner part arranged like the letter H, the end pointing back and front.

b. *White matter* (fibres) outer part.

4. Membranes, same as brain.

a. *Dura mater*, not close to the bone, but separated by fat and blood vessels.

b. *Arachnoid* forms a bag around the pia mater.

c. *Pia mater* is close to the cord and supplies it with blood.

5. Shape—It varies in its course in shape, outline, character, and appearance. It has enlargements, as

a. *cervical enlargement* at the neck—controls arms, so is thick and strong.

b. *dorsal cord*—controls chest—thin.
c. *second enlargement*—lumber—small of back—controls leg, is large.
d. *sacral*—named from bone of pelvis.
e. *terminal*—thread.

6. Fissures.
a. *Anterior fissure*—wide crevice down the front of the cord.
b. *Posterior fissure*—deep, narrow crevice down the back of the cord, dividing it into two parts.

7. Use.
a. Conduct impulses to and from the brain.
b. Act as reflex center.
Is connected with organs, glands, etc., by nerves.

D. **Cranial Nerves.**

1. Number—twelve pairs, arising from the brain, supplying the head and many internal organs, as,
olfactory nerves—those of smell.
optic nerves—those of sight.
auditory nerves—those of hearing.

2. Structure—each nerve has a set of ventral roots containing efferent fibres, and a set of dorsal roots containing afferent fibres.
Nerves may be divided, as,
a. *Motor*—carrying orders from the central nervous system to the muscles.
b. *Sensory*—carrying messages from the different parts of the body to the central nervous system.
Sometimes a motor and sensory fibre is bound together in the same nerve.

E. **Spinal Nerves.**

1. They come from the spinal cord by means of nerve trunks in pairs.
2. Number—thirty-one pairs from each side passing out through the openings between the vertebrae, each containing both motor and sensory fibres.
3. Structure—The entire nerve is surrounded by connective tissue. Inside of this covering are bundles of fibres, each bundle wrapped in connective tissue, the perineurium.
4. Roots.
a. *Anterior*—motor impulse is efferent—*from* center.
b. *Posterior*—sensory impulse is afferent—*towards* center.
5. Functions.
a. Conducting tract.
b. Center of reflex action
c. Automatic action—It is an action of a living body, not immediately due to external changes of environment, but depending upon changes arising in the organ or body itself and determined by causes other than circumstances of the moment.

1. *Types.*
a. Spontaneous action of will.
b. That belonging to the cord.
c. Arterial tone, as beating of heart, etc.
d. Muscular tone.
(*Tone* is a partially relaxed muscle).

V. **Sympathetic System.**

1. Consists of ganglia or nerve-cells scattered through the body, but chiefly on each side of the spinal cord, connected with one another and with spinal and cranial nerves.
The efferent fibres from this system control the involuntary muscles; as, helping to govern the beating of the heart, moving the intestines, regulating the use of the sweat glands, etc. The control is through a series of reflex actions.

VI. **Reflex Action.**

A. **Definition**—Reflex action is that action of the nervous system in which a stimulus is transmitted along an afferent nerve to a nerve center, from which again it is reflected along an efferent nerve to call into play some muscular, glandular, or other activity.
Examples:—Stick presented to the eye, we close it; match presented to the hand, we remove it.
Reflex action is involuntary and purposive, aiding us in daily life. Voluntary actions take place in the brain.

B. **Elements.**

1. Afferent or sensory nerve.

2. A center.
3. Efferent or motor nerve.

C. **Laws.**

1. Under differing circumstances the same stimulus calls out a different reflex response. Example:—Bread crumb on the hand, no reflex action; bread crumb in the larynx, great reflex action.

2. The reflex responses depend on the intrinsic condition of the system at the moment. Example:—Strychnine acts directly on the nerve cells of the cord. If injected into the system, the slightest touch throws one into convulsions.

D. **Use**—Aid in life—walking, eating, etc.

E. **Inhibition.**

Reflex action is not carried out freely; it is often inhibited or prevented. There is a continual inhibitory action from the brain. Example:—In a decapitated frog we have better reflex action than when the head is on.

VII. **Habit.**

A. Habit—Anything thought or done tends to repeat itself; if the act has been pleasurable or indifferent, it tends to recur; if painful, it does not.

Painful things become pleasant after a time; some pleasurable ones become painful on doing them too much.

B. Habit is due to the plasticity of the organic materials of which living beings are made.

1. *Plasticity* is that possession of a structure that is weak enough to yield to influence, but strong enough not to yield all at once.

C. Nerve currents coming through sensory nerves find expression along certain tracts of motor nerves, and emerging, leave traces. It is easier for an impulse to pass a second time than the first.

D. The nervous system in the embryo and the new-born child is in a state of tension; by a long process of selection certain tracts are more fitted than others to receive certain impulses.

E. An organ tends to grow to the mode in which it is habitually exercised. This is shown in the increase in skill, even during rest.

F. Results.

1. Habit simplifies movements, makes them more accurate, and lessens fatigue.
2. It diminishes conscious attention, because these acts become reflex in character.

G. *Physical habits* cannot be much changed after twenty. *Intellectual habits* cannot be changed after thirty.

H. Rules

1. In forming new habits or breaking old ones, begin with as strong a reason as possible; this lessens the temptation to break down.
2. Never allow an exception to occur until the habit is firmly rooted.
3. Act as soon and as often as possible along the line of the habit desired.

VIII. **Hygiene of the Nervous System.**

1. *Good food*—nerve cells require the same food as all other cells of the body.
2. *Muscular exercise*—so that the digestion and circulation is kept in good condition for sending prepared food to the nerve cells.
3. *Rest*—so the supply of food can be renewed and excess waste removed.
4. *Change of occupation*—so certain cells may rest while others are working.
5. *Sleep*—so tired nerves may rest and prepare for work. Children should have plenty of sleep, as their nerve cells are growing as well as working.
6. *Fresh air*—action of nerve cells causes oxidation of the cell substance and food. If there is a lack of fresh air, dullness and headache soon follow.
7. *Nerve exercise*—if cells are not used, they lose their power.

IX. **Effects of Tobacco.**

1. Injures the nervous control of the muscles, causing trembling, unsteadiness.
2. Bad effect on the mind, making it dull and makes people less intelligent, by preventing the brain cells from developing to their full extent. This is more noticeable in young than in older persons.
3. Moral weakness—Lack of ambition and will-power; tends to make criminals of boys.

X. **Effects of Alcohol.**

1. Destroys or injures nerve tissues.
2. Causes loss of control of muscles.
3. Causes loss of mental power.
4. Causes insanity (20% of the insane indirectly due to alcohol).
5. Makes users susceptible to germ diseases (Tuberculosis).
6. Causes delirium tremens.

7. Causes poverty and crime.
8. Shortens life.
9. Causes injurious effect on body and mind to be transmitted to children.

XI. Apoplexy—sudden inability to move and unconsciousness, caused by clogging or bursting of a blood vessel in the brain.

Paralysis—loss of power to move or feel in certain parts, due to injury of the nerves, spinal cord, or brain.

SENSATION

I. **Sensation**—first element in consciousness.

A. Any given nerve of sense produces transmitted impulses and one quality of sense. That quality can only be produced by impulses transmitted by that nerve. Example: —Eye cannot hear.—Ear cannot see.

1. **There must be—**
   a. *End* organ, as eyes, skin, etc.
   b. *Nerve.*
   c. *Center in brain.*
2. **Sensation differs.**
   a. Qualitatively—sensation differs according to the peculiar nature of the excitement.
   b. Quantitively—sensation differs according to the state of the organ and the strength of the stimulus.
3. **Senses.**
   a. **Special.**
      1. *Smell.*
      2. *Taste.*
      3. *Hearing.*
      4. *Sight.*
      5. *Skin senses.*
         a. Tactile or pressure sense.
         b. Temperature sense.
         c. Muscular sense.
         d. Joint sense, (doubtful).
   b. **Common Sensations**—giving knowledge of the condition of the body; as, hunger, thirst, and pain, are produced by impulses arising within the body.
4. **Smell**—the least intellectual of the senses.
   a. **Organ**—Mucous membrane of the upper part of the nose. It is richly supplied by fine, small nerves coming from the under side of the brain, known as the *olfactory tract.*
   b. **Condition of Substance to be Smelled**—it must exist in the atmosphere in small subdivisions. The air containing the odor, matter in the form of gas, must drift against the mucous membrane. The sensation is strongest when it is first touched.
   c. **Intensity**—depends on—
      1. Amount of smellable material.
      2. Extent of mucous membrane stimulated.
   d. **Catarrh** destroys the sense of smell and leads to serious diseases—should have the attention of a physician.
5. **Taste.**
   a. **Organs**—mucous membrane of the tongue, soft palate, forceps. Tongue is covered with papillae.
      1. *Filiform*—small cylindrical bodies.
      2. *Fungiform*—mushroom-shaped—and found dispersed among filiform at the base and side of the tongue.
      3. *Circumvallate*—are found in V-shape, reaching to base of the tongue. There are from eight to fifteen. Around the fungiform and circumvallate are *taste buds*, organs of taste. Seen chiefly at the back of the tongue and soft palate.
   b. **Condition of Substances to be Tasted**—substance must be soluble in the mouth.
      1. Flavor is a combination of taste and smell, or taste and touch.
   c. **Classes of Taste.**
      1. Bitter.
      2. Sweet.
      3. Sour.
      4. Salt.
      5. Alkaline and metallic (probably).
6. **Skin Senses.**
   a. **Organ**—skin.
      1. *Epidermis*—horny covering.
      2. *Dermis*—true skin—deep layer. It contains blood vessels, nerves, fat, etc. It is thrown into papillae, which hold organs of touch or touch corpuscles. (See Skin, page 30).

b. **Sensation of touch**—sense pressure.
Contact—gentle pressure.
c. **Intensity**—varies with the amount of stimuli and the area stimulated.
d. **Certain Areas more Sensitive than Others.**
Those having the widest and freest movement are the most sensitive. Practice improves the sensitiveness of the parts. This is a brain improvement rather than a skin improvement. Tip of tongue, lips, finger-tips.
e. **Tactile** or pressure sense—caused by mechanical pressure.
f. **Temperature** sense—caused by the rapid changes of temperature.

7. **Hearing.**
a. **Organ**—ear.
1. Structure.
a. *External Ear*—sole function to receive sound waves and convey them to the drum.
1. *Pinna* or lobe.
2. *Auditory canal.*
3. *Tympanic membrane* of the drum across the inner end of the canal.
b. *Middle Ear or Tympanum*—communicates with the interior ear and vibrates the fluids in it.
1. *Ossicles*—three small bones, forming a chain connecting the outer and inner ear.
a. *Malleus*—hammer.
b. *Incus*—anvil.
c. *Stapes*—stirrup.
2. *Mastoid cells.*
3. *Eustachian tube*—leading from the middle ear to the pharynx—air passes through it, keeping the inside pressure equal to the outside.
4. *Membrane* at inner end of drum.
c. *Internal Ear or Labyrinth*—filled with fluid.
1. *Vestibule.*
2. *Semi-circular canals*—not used for hearing, but instead help to keep the equilibrium of the body.
3. *Cochlea* or shell.
The fluid of the cochlea in the inner ear vibrates and is conveyed to the fibres of the Corti (special end organs of the auditory nerve), then to branches of the auditory nerve, and thence to the brain, and we have the sensation of hearing.
b. **Auditory sense.**
1. *Noisy sounds*—irregular.
2. *Musical sounds*—regular.
a. Intensity—depends on the height of the sound wave.
b. Pitch—depends on the wave length or frequency with which it comes.
c Quality—depends on the number of over tones.
c. **Localization of Sound**—Sound waves must strike the external ear.
d. **How Sound is Heard.**—Any sound disturbs the air, causing the particles to vibrate like waves, which finally reach the delicate tympanic membrane, striking against it and causing it to vibrate, thus setting in motion the chain of bones in the middle ear, and these in turn transmit the motion to the inner ear, the fluid, stapes, cochlea finally reaching the nerve fibres of hearing making up the auditory nerve, which conducts the stimulus to the brain and gives sensation of hearing the sound.
e. **Care of Ears.**
Do not clean the ear with a hard object pushed into the ear. It may injure the ear drum. If an insect gets into the ear, pour in a little warm oil or warm water. Striking the ear may injure the ear drum.

8. **Sight**—the most intellectual sense.
a. **Organ**—Eye-ball (spherical), which connects with the optic nerve going to the brain.
1. *Sclerotic coat*—outer wall of tough membrane.
2. *Choroid*—loose middle coat, a delicate membraneous lining, which is dark in color to prevent internal reflection of rays of light entering the eye.
3. *Retina*—inner coat—very delicate nervous structure, which connects with the optic nerve. Here the stimuli is set up. It is very sensitive to light.
4. *Cornea*—a thin, hard, transparent substance in the front of the eye, which is a continuation of the sclerotic coat.
5. *Crystalline lens*—a little behind the cornea there is a double con-

vex lens which focuses the object on the retina by becoming thinner or thicker, as the object is far or near.

6. *Iris*—In front of the lens is a circular-colored curtain, continuation of the choroid coat, which determines the color of the eye.

7. *Pupil*—an opening in the center, which regulates the amount of light entering the eye.

8. *Vitreous humor*—a transparent, jelly-like substance, which fills the ball of the eye behind the lens.

9. *Aqueous humor*—a liquid filling the space between the cornea and the crystalline lens.

b. **Eyebrows**—one over each eye to prevent perspiration from running down into the eye.

c. **Eyelids**—upper and lower over each eye to protect the eye-ball from dust and light.

d. **Eyelashes**—fringe of hair on the edge of each eyelid to protect the eye from dust and light.

e. **Eye-Sockets**—deep bony cavities, which protect the eye from blows.

f. **Lachrymal Glands**—One in each upper eyelid—secreting tears which enter the eye at the upper, outer corner, flow across the eye to the lower inner corner, entering the lachrymal duct and so down to the nasal passage.

Tears—cleanse the eye of dust and germs. Sometimes they secrete so rapidly that they overflow on the cheek and we say the person is *crying*.

g. The **Meibomian Glands**—found in each eyelid; they secrete oil and empty it along edges of the eyelids, preventing the tears from overflowing. If these glands do not secrete properly, scales form at the roots of the eyelashes, drying them, so they drop off.

h. **How We See.**—By means of the crystalline lens rays of light coming to the eye from an object are brought to a focus on the retina, when, just as in the screen of the camera, a laterally inverted image is formed. The retina is an expansion of the optic nerve, and the optic nerve, being stimulated by the rays which come from the image, convey the impression to the mind or brain.

i. A **Near-sighted Eye** is one that cannot see objects unless they are very near the eye. The defect is usually due to the shape of the eye. The eye-ball being too long, the image is formed in front of the retina. This defect is corrected by using concave lenses which spread the rays of light and focus the image back on the retina.

j. A **Far-sighted Eye** is one that can see objects at a far distance more clearly than if near the eye. This defect is usually due to the shape of the eye. The eye-ball being too short, the image is formed in back of the retina. This defect is corrected by using convex lenses which converge the rays of light, focusing the image on the retina.

k. **Astigmatism**—unequal curvature of the lens or cornea—some parts being flatter than others. Eye-glasses must be ground to suit the eye.

l. **Color-Blindness**—incurable. Most colors can be recognized, except green and red with their various shades.

m. **Injuries.**

1. Cinders or dirt entering the eye irritates the lining of the lids and the surface of the cornea. Pull the upper lid down over the eye and roll the eye, opening quickly; or turn the upper lid back over a match-stick and with the corner of a clean handkerchief remove the speck.

2. Sore or Inflamed Eyes—bathe with a solution of boracic acid dissolved in warm water.

3. Cataract—due to crystalline lens becoming opaque—remedied only by an operation.

n. **Tobacco**—excessive use by the young causes vision to be weak and uncertain.

o. **Alcohol**—eyes become blood-shot and the optic nerve is sometimes injured.

p. **Care of Eye.**

1. Wear eye-glasses when needed, but have them properly fitted to the eye. This frequently prevents headaches, indigestion, nervousness, dullness.

2. Good light when reading or working. Let it fall over the left shoulder on the book or work, coming from the back, but never shining into the eyes.

3. Never read when lying down, assume a correct sitting or standing posture.

4. Rest the eyes occasionally.

5. Keep dust and dirt from the eyes.

6. Bathe with boracic acid solution occasionally.

EXCRETORY SYSTEM

I. **Lungs**—Carbon dioxide removed from the blood through the lungs. (See Lungs, page 12).

II. **Kidneys.**

A. Two reddish-brown, bean-shaped organs, about four inches long, one on each side of the back-bone, below the diaphragm, against the back of the abdominal cavity.

B. **Structure** – The artery reaching the kidney branches into thousands of parts, each part ending in a tiny roll of capillaries, each of which is enclosed in a minute crooked tube. These tubes unite and carry the urine to the inner side of the kidney, where it is received in the pelvis and passed into the *ureter*, a tube leading to the *bladder*. This is a globular sac, about the size of a fist. Its muscular walls contract, forcing out the urine to the external opening.

C. **Use**—to excrete *urea*, which is broken-down flesh, *uric acid*, and *water*. Kidneys purify the blood by removing the poisonous proteids, wastes, and water.

D. **Urine** – a yellowish liquid containing water and solids, more than half of which is urea.

E. **Hygiene** – Between two and three quarts of water should be taken daily by an adult to properly wash out the waste substances, thus helping to prevent rheumatism, constipation, etc. More water is needed in summer than in winter, as so much is lost by perspiration.

F. **Brights' Disease** - inflammation of the kidneys, which are overworked, due to the albumen of the blood escaping with the urine. It is caused sometimes by too much meat and nitrogenous food being eaten for a long period with little exercise It is also caused by alcohol and sometimes follows diseases where a large amount of waste tissue must pass through the kidneys. (Scarlet Fever).

III. **Skin.**

A. **Structure**—two layers.

1. Epidermis – or cuticle.
2. Dermis—cutis or true skin.

B. **Epidermis.**

1. Outer layer—horny.
2. Inner layer—pigmentary.
3. Structure – epithelial cells, the lower ones being cubical, but gradually changing as they near the surface, becoming flat. It contains no nerves or blood vessels, but has many tubes ending in *pores* leading from the sweat glands. The cells on the surface are constantly shed while new ones are developed from the lower layers.
4. **Use.**
   a. To prevent injuries to the delicate structures beneath, such as the nerves and blood capillaries.
   b. To prevent pain caused by touching naked nerve ends.
   c. To keep germs from entering the tissues.
5. **Complexion** – this is due largely to the pigment in the lower part of the epidermis. Washing with soft water and good soap, drinking plenty of water, exercising in the open air, and keeping the mind free from worry, will usually give a good complexion.
   a. **Freckle** – a spot where the pigment is abundant.
6. **Modifications.**
   a. **Hair.**
      1. Structure—minute horny scales—hair widely distributed. Each hair is in a tube-like sac-follicle made by the epidermis dipping in to the lower tissues. At the bottom of each follicle is the papilla made of capillaries and tissue from which the new hair grows as soon as the old is pulled out. A little cup-like cavity in the end of the hair fits over the papilla and thus receives its nourishment from the blood.
      2. Baldness—is due to the hair not being properly nourished. This is caused sometimes by the exclusion of fresh air from the head and by pressure shutting off to a great extent the blood.
      3. Dandruff is the result of an unhealthy condition of the cells of the scalp – wash the scalp and hair frequently.
      4. Gray Hair—due to the presence of air instead of pigment in the central part,
      5. **Care of Hair.**
         a. It should be brushed well, as this spreads the oil and also

causes good circulation, thus providing it with food and oxygen and carrying away the waste.

b. The hair should be washed to remove dust and oil. If very oily, use a little ammonia in the water.

b. **Nails.**

1. They are hardened epidermis found at the ends of the fingers and toes, growing outward.

2. PARTS - the *root* and *matrix*, portion of the epidermis which, if injured or destroyed, prevents the growth of a new nail.

3 USE.

a. To protect the ends of the finger.

b. To pick up objects.

4. HYGIENE—Nails should be filed off even with the fingers every morning and the dirt removed each time the hands are washed.

C. **Dermis.**

1. STRUCTURE—papillae.

2. PROPERTIES – soft, very sensitive, elastic, quite thick.

3. CONTENTS—blood vessels, nerves, lymphatics, sebaceous and sweat glands, hair follicles.

4. USE—It is the seat of pain, pressure, and temperature. The last two sensations are obtained only from the nerves in the skin. It regulates temperature by controlling the amount of blood coming to the skin, and by the action of the sweat glands; when warm, the capillaries enlarge so that the hot blood can come to the surface to be cooled.

5. **Sweat Glands.**

a. About 2,000,000 – thickest in the palms of the hand, on the soles of the feet, and on the forehead.

b. Each gland consists of a tiny coiled tube in the dermis and a duct extending in an irregular course through the epidermis to the surface, ending in the pores of the skin.

c. PERSPIRATION – the fluid given forth by the sweat glands. It is increased by heat or exercise.

1. Ninety per cent. is water, the rest is mainly salt and urea.

2. *Use* – It controls the temperature of the body. The heat flowing in great quantities, evaporates and so cools the skin. Sitting in a wind after perspiring freely, frequently causes a cold.

6. **Sebaceous or Oil Glands.**

a. Found in the skin wherever hair grows.

b. Each gland is as large as the point of a pin, arranged like a bunch of grapes and opening by a single duct near the top of the sac enclosing the hair root.

c. *Secretion*—oily, semi-liquid.

d. *Use* – to keep the skin and hair soft.

D. **Use of the skin.**

1. Protective covering for the body.

2. Organ of feeling - nerves of touch end in the skin.

3. Regulates the heat of the body.

4. Excretes water from the body.

E. **Alcohol.**

1. Enlarges the arteries and capillaries of the skin, making the face red.

2. Makes the skin of the face puffy and blotched.

3. Cools the body rapidly in cold weather by bringing so much blood to the surface.

F. **Injuries to the skin.**

1. CALLOUS SPOTS are thickened skin due to pressure or friction for a long time.

2. BLISTERS or CORNS – due to hard pressure or friction.

3. BURNS—due to fire, hot objects – if serious, skin grafting is done.

SCALDS—due to hot water or steam.

a. Use an ointment made by mixing half limewater and half linseed oil, if the skin is broken; if not, use water with baking soda dissolved in it. Bandage to keep out the air. Blisters should not be touched for twenty-four hours, then they should be opened and the sides pressed gently together to let out the water. Then bandage with oil.

b. FIRE.

Shut all doors and windows to prevent draughts. Turn in an alarm. Wrap a wet towel about the head and over the mouth and nostrils, so as not to inhale the flames. Keep close to the wall and near the floor, as there is less smoke there.

c. Clothing on Fire.—Roll patient in the dirt or wrap in blankets. Soak off clothing, if it adheres to the skin, with water in which baking soda has been dissolved.

4. Bruises—due to blows by blunt instruments - dip in hot water and rub.

5. Wounds—by rusty nails, etc.—cleanse with water and antiseptic—squeeze so as to cause bleeding. Fishhook, put through, if possible, and cut off hook before removing it. Then treat as above.

6. Bandaging—Use triangular bandage - cheese cloth is cheap and serviceable, or handkerchief can be folded in triangle when in a hurry. In tying, use square knots.

7. Sunstroke - due to fatigue and exposure to the sun on a hot day. Patient is sick to stomach, weak, sleepy, or nearly unconscious, skin dry, eyes bloodshot.—Keep the patient cool, bathe with cold water and put cracked ice on the head. No alcohol.

8. Heat Exhaustion—skin is cold, give hot coffee and put to bed.

9. Fever - not enough heat is lost, the sweat glands refusing to work.

10. Chill—due to the blood being cut off from the skin.

11. Snake-Bite - tablespoon of whiskey every half-hour, tie string around limb above wound, send for a physician.

12. Sting of Bee, etc.—bathe with ammonia.

13. Poison - empty stomach by giving an emetic (tablespoon of mustard or two of salt to a glass of warm water), which will cause vomiting, unless the poison is acid or alkali.

Poison Ivy—wash with soap suds and then apply equal parts of alcohol and water with as much sugar of lead as will dissolve.

G. **Clothing**—should be adapted to weather and buildings.

1. Purpose.—To retain bodily heat; to protect from bruises.

2. Woolen clothing is warmer than cotton or linen because it has numerous air-spaces. Cold or wet clothing touching the skin takes heat from the body too rapidly so cold may result; therefore, wool is safer to wear next to the skin even in summer.

H. **Bathing.**

1. Dead cells of the skin, oil, perspiration, dust, and dirt, clogging the pores and thus preventing more waste from escaping, make it necessary to wash the skin frequently to prevent the breeding of germs. Warm water and soap is necessary to cleanse the skin properly. Never bathe just before or within two hours after eating, as the blood is drawn from the digestive organs.

2 Cold Baths - the blood vessels of the skin contract and force the blood to the internal organs, thus quickening respiration and circulation. It sends blood to the brain and a great amount of food is oxidized, thus rousing the energies. After a bath there is usually a reaction, the blood rushing back to the skin and warming it. If this does not take place, the bath is injurious. It should not be taken when one is tired or hot; therefore, early morning is the best time

3 Warm Baths open the pores of the skin, drawing the blood to the surface away from the muscles and internal organs. Before retiring is the best time for a hot bath. It sometimes prevents insomnia.

DISEASE

I. **Classes.**

A. **Infectious**—due to germs feeding on the body.

1. **Contagious**—germs breathed in by coming in contact with the sick or where they have been, by using common drinking-cups, and from the sputum of the patient. (Small pox, tuberculosis).

2. **Non-contagious** - germs conveyed by mosquitoes or by an instrument piercing the skin, not by contact with the sick. (Yellow fever, lockjaw).

B **Non-infectious**—due to change of growth or work of certain cells. (Insanity, cancer).

II. **Prevention of Disease.**

A. Develop the tissues so they will have power to destroy disease germs. This is done by nutritious food, sleep, fresh air day and night, at least one hour of exercise a day. Vaccines and anti-toxins also prevent disease. (See Health Rules, page 16).

B. Destroy germs in excretions from the sick so they will not reach the well.

C. Prevent careless people from scattering germs.

D. Isolate the sick by *quarantine.*